

Remarks

Claims Status

Claims 1-3, 5, 8-12, 16, 37 and 86 are pending.

Claims 1, 9, 37 and 86 are currently amended.

Claim 4 is canceled.

Correction of Informalities in Drawings in Accordance with 37 CFR § 1.85

A drawing correction, proposed by applicant in a Response filed with the U.S.P.T.O. on 9 January 2003, in the present application, has been approved. Accordingly, the Office is requiring a proper drawing correction in reply to the 27 March 2003 Office Action in order to avoid abandonment of the instant application.

Accordingly, applicant submits herein, in Appendix A, a corrected "Figure 1" showing incorporation therein of the term "Prior Art", which is in full compliance with the requirements of 37 CFR § 1.85.

To formally effect the correction of such drawing. Applicant respectfully requests of the Office to replace the earlier-submitted, original Figure 1, with the enclosed corrected version.

Submission of Formal Drawings in Accordance with 37 CFR § 1.85

In response to the "Detailed Action" section of the March 27, 2003 Office Action in the present application, wherein corrected drawings were required to correct informalities in same, applicant encloses and submits herein, in Appendix A, formal drawings for Figures 1-11 (7 sheets) in substitution of the originally filed correspondingly numbered patent drawings. The new formal drawings are in accordance with 37 CFR § 1.85 and serve to overcome all objections previously noted by the Office with respect to drawings in the present case.

Claims Rejection Under 35 U.S.C. § 112

Claims 1-5, 8-12, 16, and 37 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter, which applicant regards as the invention. More specifically, the Office indicates that the newly added limitation to the claims that "at least two of x are different" is unclear.

In response, applicant amends herein, independent claims 1 and 37 to replace the metalloamide formula " $M(NR^1R^2)_x$," with " $M(NR_2)_x(NR'_2)_y$," where x is from 1 to 5, y is from 1 to 5 and $x+y$ is equal to the oxidation state of metal M . The amended formulation is fully supported by the present specification at page 14, first full paragraph, which has been reproduced below for the Examiner's convenience.

Examples of metalloamide compounds which may be usefully employed in the present invention include, without limitation, $Zr(NMe_2)_4$, $Zr(NEt_2)_4$, $Ta(NEt_2)_5$, $Ta(NMeEt)_5$, $Zr(NiPr_2)_4$, $Zr(NMe_2)_2(NPr_2)_2$, $Zr(NC_6H_{11})_4$, $Zr(NEt_2)_2(NPr_2)_2$, $Hf(NEt_2)_4$, $Hf(NMe_2)_4$, $La(NMe_2)_3$, $La(NEt_2)_3$, $Al(NMe_2)_3$, $Al(NEt_2)_3$, $Y(NMe_2)_3$, $Y(NEt_2)_3$, $Ti(NMe_2)_4$, $Ti(NEt_2)_4$, $Ta(NMe_2)_5$, $Ta(NEt_2)_5$, wherein Me represents methyl, Et represents ethyl, Pr represents propyl, and iPr represents isopropyl. Preferred metalloamide source reagent compounds useful in the present invention include $Zr(NMe_2)_4$, $Zr(NEt_2)_4$, $Hf(NEt_2)_4$ and $Hf(NMe_2)_4$.

Further, it is to be noted that the amended metalloamide formulation replaces R^1 and R^2 with R and R' respectively, so as to remove the potential for confusion between the subscript 2 on the R groups and superscripts 1 and 2.

By such amendment, claims 1 and 37 are clear and definite in accordance with 35 U.S.C. § 112, second paragraph. Moreover, such amendment renders claims 2-3, 8-12 and 16, which depend from claim 1, also of definite form.

On the basis of the foregoing remarks, it is submitted that claims 1-3, 5, 8-12, 16, and 37 are fully supported by the disclosure of the instant specification, as well as definite within the meaning of 35 USC § 112 second paragraph, and applicant respectfully requests Examiner Kielin to withdraw the rejection of such claims.

Claims Rejections Under 35 U.S.C. § 102(b)

In the March 27, 2003 Office Action, claims 1-3, 11, 12 and 37 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,583,205 to William S. Rees, Jr. (hereinafter referred to as "Rees"). Specifically, the Examiner states that,

Regarding claims 1 and 37, Rees discloses a CVD (chemical vapor deposition) precursor composition for forming a thin film dielectric on a substrate, including at least one metalloamide source reagent compound, or a vapor source reagent mixture including a metalloamide source reagent compound, having the formula $M(NR_1R_2)_x(NR'_1R'_2)_y$ (col. 5, line 20; col. 6, line 45) wherein M is a metal selected from Li, Zn, Y, La, lanthanide and actinide series elements (called the "F-series"), (Abstract; col. 6, lines 27-30; col. 7,

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Table 1); N is nitrogen; each of R^1 and R^2 is the same or different and is independently selected from the group consisting of H, aryl, perfluoroaryl, C_1-C_8 alkyl, C_1-C_8 perfluoroalkyl, and alkylsilyl; (col. 3, lines 24-43; col. 5, lines 1-28); and $x+y$ is the oxidation state on metal M. (See also col. 6, lines 6-56).

Such rejection of the claims is traversed in application to the claims as now amended, and in light of the ensuing remarks.

Regarding Examiner Kielin's statement (above), where "each of R^1 and R^2 is the same or different and is independently selected from the group consisting of H, aryl, perfluoroaryl, C_1-C_8 alkyl, C_1-C_8 perfluoroalkyl, and alkylsilyl" applicant respectfully requests clarification as to the specific location in Rees, for the citation of "perfluoroaryl, and C_1-C_8 perfluoroalkyl".

The present claimed invention is directed to a precursor composition for chemical vapor deposition formation of dielectric thin films. The precursor composition includes at least one metalloamide source reagent compound having a formula " $M(NR_2)_x(NR'_2)_y$ " wherein M is a metal selected from Hf, Y, La, Lanthanide series elements, Ta, and Al; N is nitrogen; each of R and R' is independently selected from H, aryl, perfluoroaryl, C_1-C_8 alkyl, C_1-C_8 perfluoroalkyl, and alkylsilyl; x is from 1 to 5; y is from 1 to 5; and $x+y$ is equal to the oxidation state of metal M. Thus, the present invention requires that at least two amino ligand groups be bonded to metal M and that the at least two amino groups be different.

Rees is directed to a metalorganic chemical vapor deposition method for deposition of an F-series metal onto a semiconductor substrate. The F-series metal of the amide is ligated to at least one amide ligand having a generic formula $-NR_1R_2$, where R_1 and R_2 are independently alkyl, alkenyl, aryl or di- or trialkyl-substituted silyl, or together with the nitrogen atom to which they are attached comprise a heterocyclic ring (col. 2, lines 54-67). Rees further teaches that when the F-series metal is bonded to more than one amide, the metal amide may have a similar generic formula $(NR_1R_2-M-NR'_1R'_2)$, where the R groups are as described above (col. 5, lines 15-28).

Rees fails to define that which he considers to be F-series metals. As such, applicant referred to CRC Handbook of Chemistry and Physics 70th Edition, 1989-1990, page B-4 (a copy of which is included herein in Appendix B) for a listing of elements having f-orbital electrons. According to the CRC Handbook the following elements include f-orbital electrons, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, Fr, Ra, Ac, Th,

Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No and Lr. And although, (Y) yttrium does not comprise f-orbital electrons, Rees identifies same as an F-series metal, in Table 1, Column 7.

Moreover, among the 44 metals identified herein as having f-orbital electrons, Rees discloses only Er (erbium), La (lanthanum) and Pr (praseodymium). Still further, Rees discloses only trimethylsilyl, Er, La, Pr and Y amides.

Anticipation requires that a prior art reference disclose each and every element of a claim with sufficient clarity to prove its existence in the prior art. According to MPEP 2131.02, anticipation can only be found if a class of substituents are sufficiently limited or well delineated.

On such basis, applicant's present claims, as amended, are not anticipated by Rees as Rees fails to sufficiently limit or delineate a metalloamide composition that requires (emphasis added) two different amino groups ($-NR_1R_2$) bound to a metal center M. Moreover, Rees fails to disclose a single specific R group other than trimethylsilane.

Applicant's present independent claims 1 and 37 and 2-3, 11, and 12 depending therefrom, exclude the metalloamide species taught by Rees and are therefore patentably distinct under 35 U.S.C. § 102(b). Accordingly, applicant respectfully requests the Examiner withdraw the rejection under 35 U.S.C. § 102(b) of claims 1-3, 11, 12, and 37.

Claims Rejections Under 35 U.S.C. § 103(a)

In the March 27, 2003 Office Action, Examiner Kielin set forth the following claim rejections under 35 U.S.C. § 103(a):

Claims 8-10 and 16 as being unpatentable over Rees in view of U.S. Patent No. 6,159,855 issued to Brian A. Vaartstra, (hereinafter referred to as "Vaartstra"); and

Claims 1, 4, 5, 37 and 86 as being unpatentable over the article Bradley and Thomas, "Metallo-organic compounds containing metal-nitrogen bonds. Part I. Some Dialkylamino-derivatives of titanium and zirconium" Journal of the Chemical Society, 1960, pp. 3857-3861 (hereinafter referred to as "Bradley") in view of either of Rees and Vaartstra.

Such rejections of the claims are traversed in application to the claims as now amended, and in light of the ensuing remarks.

Regarding claims 8-10, Examiner Kielin states,

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use [sic] the solvents of Vaartstra as the solvents in the Rees CVD precursor composition, because Vaartstra teaches that metalloamides are soluble in such solvents for the purpose of CVD.

Regarding claim 16, Examiner Kielin states,

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use multiple metalloamides in a CVD precursor of Rees to achieve a deposited layer having both metals, as taught to be beneficial in Vaartstra.

Applicant's claims 8-10 and 16, as amended, are directed to a precursor composition for chemical vapor deposition formation of dielectric thin films. The precursor composition includes a solvent medium and at least one metalloamide source reagent having a formula " $M(NR_2)_x(NR'_2)_y$ " wherein M is a metal selected from Hf, Y, La, Lanthanide series elements, Ta, and Al; N is nitrogen; each of R and R' is independently selected from H, aryl, perfluoroaryl, C_1 - C_8 alkyl, C_1 - C_8 perfluoroalkyl, and alkylsilyl; x is from 1 to 5; y is from 1 to 5; and x+y is equal to the oxidation state of metal M. The solvent medium is selected from ethers, glymes, tetraglymes, amines, polyamines, alcohols, glycols, aliphatic hydrocarbon solvents, aromatic hydrocarbon solvents, cyclic ethers and combinations of two or more of the foregoing. Thus, the instant claims require that the precursor composition include a solvent and a metalloamide source reagent having at least two amino ligand groups bonded to metal M wherein the at least two amino groups are different.

Rees is directed to a metalorganic chemical vapor deposition method for deposition of an f-series metal onto a semiconductor substrate. The F-series metal of the amide is ligated to at least one amide ligand having a generic formula $-NR_1R_2$, where R_1 and R_2 are independently alkyl, alkenyl, aryl or di- or trialkyl-substituted silyl, or together with the nitrogen atom to which they are attached comprise a heterocyclic ring (col. 2, lines 54-67). Rees further teaches that when the f-series metal is bonded to more than one amide, the metal amide may have a similar generic formula $(NR_1R_2-M-NR'_1R'_2)$, where the R groups are as described above (col. 5, lines 15-28).

Rees fails to sufficiently limit or delineate metalloamide compositions requiring (emphasis added) two different amino groups bound to a metal center M. Moreover, Rees is silent as to the use of solvents with the metalloamide compositions.

Vaartstra is directed to metalloamide compounds useful for chemical vapor deposition of multi-metallic films, and cites preferred metals of the invention as Groups IA, IIA, IIIA, IVA and the transition metals (column 4, lines 10-31). Vaartstra defines the transition metals as encompassing elements of atomic number 21 through 30 (scandium through zinc), 39 through 48 (yttrium through cadmium), 57 through 79 (lanthanum through gold) and all elements from atomic number 89 (actinium) on. In total, Vaartstra discloses 89 metals for use in metalloamide compounds.

Vaartstra's metalloamide compounds include a metal from the list above and an amino group, wherein each amino group comprises at least two N-R bonds where R is disclosed as H or carbon. (See column 4, lines 54-57).

Regarding solvents and the combination of metalloamides therewith, Vaartstra teaches at column 8, lines 8-24,

The inventive composition and source material may be prepared by combining the first and second metalloamide compounds and mixing them together. The first and second metalloamide compounds may be mixed together by hand, or by mechanical means. As explained in more detail below, a solvent may also be present in the inventive composition and source material. Thus, the first and second metalloamide compounds may be combined by mixing one or the other with a solvent, and then adding the remaining metalloamide compound(s) to the solvent/metalloamide mixture. For example, the metalloamide compounds and solvent(s) may be combined and the combination stirred or blended to achieve a homogeneous or heterogeneous mixture. A homogeneous mixture is generally preferred. If the metalloamide compounds do not readily dissolve in the solvent(s) at room temperature, then some heating may be applied to facilitate the dissolution process.

Vaartstra sets forth at column 6, lines 6-56, 46 bi-metalloamide compositions comprising amino groups bonded to a metal center where the particular amino group does not vary within a metal center.

Moreover, Vaartstra teaches that useful solvents include, without limitation, aliphatic hydrocarbons (e.g., hexanes), preferably having three to twenty carbon atoms (i.e., C3-C20 aliphatic hydrocarbons), and more preferably being C5-C10 aliphatic hydrocarbons, aromatic

hydrocarbons (e.g., benzene, toluene, xylene(s)), preferably C6-C20 aromatic hydrocarbons and more preferably C6-C10 aromatic hydrocarbons, ethers (e.g., diethyl ether, ethyl butyl ether), polyethers (e.g., polyethylene oxides), thioethers (e.g., dimethylsulfide), esters (e.g., ethyl acetate), ammonia, amines (e.g., triethylamine), polyamines (e.g. ethylenediamine and alkylated derivatives thereof), nitrites (e.g., acetonitrile), and silicone oils.

The solvent component(s) and the metalloamide compounds as taught by Vaartstra must be combined, stirred or blended to achieve a homogenous or heterogeneous mixture. Bi-metalloamides as well as mixtures of amides have solubility properties different from single component metalloamide compositions.

Vaartstra's listing of metals, potential N-R combinations and potential solvent combinations is so extensive as to logically be construed as exclusive in character of combinations of metalloamides and solvent components.

According to MPEP 2142:

To establish a *prima facie* case of obviousness, *three* basic criteria *must* be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Applicant submits that the Examiner's position in essence, with respect to the level of ordinary skill in the art at the time of the invention "to sue [sic] the solvents of Vaartstra as the solvents in the Rees CVD precursor composition, because Vaartstra teaches that metalloamides are soluble in such solvents for the purpose of CVD" is that it would have been obvious for one of ordinary skill in the art to vary every parameter of Rees's 46 theoretical f-series metalloamide compositions and every parameter of Vaartstra's generic solvent components in order to optimize the effectiveness of the solvent composition for each of the numerous potential metalloamide compositions, regardless of the fact that there is no evidence in the record that the prior art in any way recognizes that a metalloamide of the formula $M(NR_2)_x(NR'_2)_y$ where M is Hf, Y, La,

Lanthanide series elements, Ta, or Al and x is from 1 to 5; y is from 1 to 5; and x+y is equal to the oxidation state of metal M, would be beneficial in any respect. Thus, the Examiner's assertion that the prior art of record require that at least two amino ligand groups be bonded to metal M and that the at least two amino groups be different is simply an "obvious to try" rejection, which is wholly improper under § 103.

Regarding claims 1, 4, 5, 37 and 86 Examiner Kielin states,

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the compounds of Bradley and Thomas as a CVD precursors [sic], as taught in each of Rees and Vaartstra, because one of ordinary skill would recognize that they could be used for such purpose given their similarity to those compounds of Rees and Vaartstra.

Bradley is directed to the synthesis and study of dialkylamino-derivatives of titanium and zirconium. Specifically, Bradley discloses $\text{Ti}(\text{NMe}_2)(\text{NPr}^i)_3$, $\text{Ti}(\text{NMe}_2)_3(\text{NPr}^i)_2$, $\text{Ti}(\text{NMe}_2)(\text{NPr}^n)_3$, $\text{Ti}(\text{NMe}_2)(\text{NBu}^i)_3$, $\text{Ti}(\text{Me}_2)(\text{NC}_6\text{H}_{12})_3$, $\text{Ti}(\text{Me}_2)_3(\text{NC}_7\text{H}_{14})$, $\text{Zr}(\text{NMe}_2)_3(\text{NPr}^i)_3$, and $\text{Zr}(\text{NEt}_2)_3(\text{NPr}^i)_2$.

The present claimed invention is directed to a precursor composition for chemical vapor deposition formation of dielectric thin films. The precursor composition includes at least one metalloamide source reagent compound having a formula " $\text{M}(\text{NR}_2)_x(\text{NR}'_2)_y$ " wherein M is a metal selected from Hf, Y, La, Lanthanide series elements, Ta, and Al, N is nitrogen; each of R and R' is independently selected from H, aryl, perfluoroaryl, $\text{C}_1\text{-C}_8$ alkyl, $\text{C}_1\text{-C}_8$ perfluoroalkyl, and alkylsilyl; x is from 1 to 5; y is from 1 to 5; and x+y is equal to the oxidation state of metal M. Thus, the present invention requires that at least two amino ligand groups be bonded to metal M and that the at least two amino groups be different. Moreover, the present claims have been amended to exclude zirconium and titanium as metals for use in metalloamide compositions.

In establishing a *prima facie* case of obviousness the prior art relied upon must be analogous prior art. Bradley synthesizes a series of zirconium and titanium tetrakisdialkylamino- derivatives to study the nature of metal-nitrogen bonds in covalent neutral compounds (page 3858, lines 10-13). And as the present claims are absent any reference to zirconium or titanium metalloamide species, the Bradley reference is rendered non-analogous art.

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Accordingly, applicant respectfully requests that the Bradley disclosure be removed as a primary reference in the instant obviousness rejection against claims 1, 5, 37 and 86. Applicant further requests the withdrawal of the instant obviousness rejection under 35 U.S.C. §103(a) based on Bradley in view of Vaartstra or Rees.

Based on the foregoing evidence, all pending claims, 1-3, 5, 8-12, 16, 37 and 86 as amended are patentably distinguished over the art of record, and applicant respectfully requests the Examiner withdraw the rejections under 35 U.S.C. §103(a) of claims 1, 5, 8-10, 16, 37 and 86 in favor of a Notice of Allowance.

Request for Continued Examination Under 35 U.S.C. §132(b)

A Request for Continued Examination (Appendix C) is concurrently filed herein under 35 U.S.C. §132(b).

Fees Due and Payable

With the entry of this amendment, please deduct the amount of \$750 as the fee due in connection with applicant's Request for Continued Examination Under 35 U.S.C. §132(b) from Deposit Account No. 50-0860 of Advanced Technology Materials Inc.

Should the Office determine that any additional fee or charge is payable in connection with the entry of this Amendment, or furtherance of the present application, the Office is hereby authorized to charge any such fee to Deposit Account No. 50-0860.

CONCLUSION

Applicants have now made an earnest attempt to place this case in condition for allowance. For the foregoing reasons and for other reasons clearly apparent, applicants respectfully request reexamination and reconsideration of this application and full allowance of claims 1-3, 5, 8-12, 16, 37 and 86.

The Examiner is therefore requested to take cognizance of the claims as amended herein, and to responsively issue a Notice of Allowability and Notice of Allowance for such claims 1-5, 8-12, 16, 37 and 86.

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In the event that any issues remain outstanding, incident to the formal allowance of the application, the Examiner is requested to contact the undersigned agent at (203) 794-1100 ext. 4184 to discuss their resolution, in order that this application may be passed to issue at an early date.

Respectfully submitted.



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Appendix A

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